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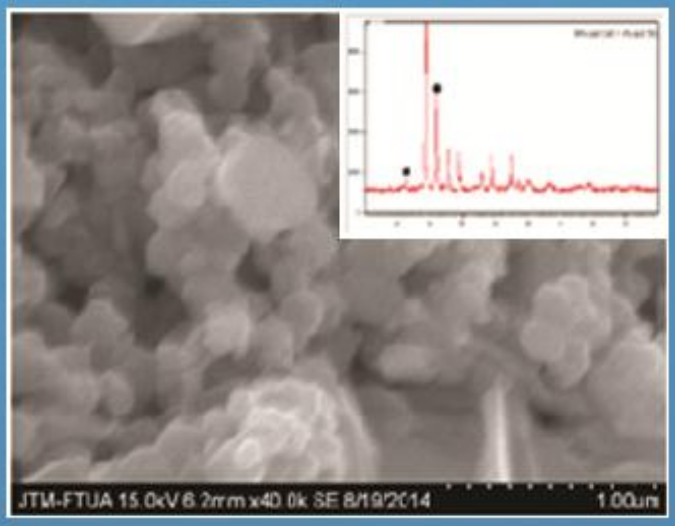
THE 4th INTERNATIONAL CONFERENCE ON THEORETICAL AND APPLIED PHYSICS (ICTAP) 2014

Bali, Indonesia
16 - 17 October 2014



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PREFACE

The *4th International Conference on Theoretical and Applied Physics* (*ICTAP*) 2014 was held in Bali, Indonesia on October 16-17, 2014. It is an international conference covering a wide subject in the field of theoretical and applied physics. This Conference was organized by the Department of Physics, Udayana University (UNUD) and Indonesian Physical Society (HFI). Many people have unreservedly and enthusiastically participated in the planning and preparation of this conference, including the Organizing and Scientific Committees, the speakers, the conference officer, students, etc. Thank you all for your positive attitude and fantastic support. Thanks to all invited speakers: Prof. Dr. Yusaku Fujii (Gunma University, Japan), Prof. Jakrapong Kaewkhao, Ph.D (Nakhon Pathom Rajabhat University, Thailand), Prof. Dr. Hong Joo Kim (Kyungpook National University, Republic of Korea) and Prof. Dr. Ing Mitra Djamal (ITB) that you have accepted our invitation. The financial support from Udayana University is gratefully acknowledged. ICTAP 2014 is aimed at providing the much needed forum of scientific communication and interaction among distinguished scientists working in the field of physics and related fields.

This event was also designed to offer the opportunity of making direct contact for the young Indonesian scientists and students with well-known scientists abroad and thereby fostering the existing research collaborations and extending international research networking for the future.

More than 106 authors from 6 countries have submitted their work in the conference. ICTAP 2014 finally accepted 57 original research papers after a peer review process. During the conference, 14 parallel sessions were held in order to advance and contribute to specific research area in physics.

Finally, special thanks to you, the delegates, for supplying the input needed for successful scientific conferences. We wholeheartedly welcome you and hope you find ICTAP 2014 as successful and rewarding as we envision it to be.

Denpasar, 12 May 2016

Editors

Ni Nyoman Rupiasih, Ph.D.
Dr. Wayan Gede Suharta
Dr. Hery Suyanto

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Analysis of Subsurface Materials Based on the Value of Medium Permeability in the Pangkep Karst Region, South Sulawesi

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Abstract. This research is a field survey to reveal the characteristics of the subsurface based on the value of medium permeability Pangkep karst region. Data were collected using geoelectric resistivity Wenner configuration for subsurface characteristics with path length 90 m with as much data as the 145 data, then processed using software Res2dinV. For medium permeability measurements carried out with a drill to obtain samples and analyzed using the falling head method. The results of data analysis showed that the depth of up to 15,70 m for the subsurface characteristics with values 279-1,612 Ωm, types of materials such as sand, clay, slate, surface water, and groundwater. The value 1,612-6,196 Ωm for the type of quartz, granite, basalt, and limestone. The price 15,360-388,554 Ωm for the type of material andesite, rocks, salt. While the value of permeability for 6 samples is 0.87 D, 0.97 D, 0.053 D, 0.89 D, 0.63 D, and 0.87 D.

Keywords: Subsurface, medium permeability, karst, geoelectric resistivity, falling head.
PACS: 91.25.QI

INTRODUCTION

The phenomenon of karst in South Sulawesi is one of landscape phenomena very interesting because of its uniqueness. Topographically, area of karst Pangkep shaped towers located in a contingent with Maros karst area in South Sulawesi. The extent of approximately 194.93 km^2 with limestone reserves of 1.46 billion tons. Morphology of karst Pangkep formed on Tonasa formations limestone aged the Eocene to the middle Miocene, about 50-15 million years ago. At the start of its formation, karst mountainous region is a shallow water with coral reef exposure very wide on the edge of the Eurasian continent. The next process, the developing limestone exposure for 35 million years and geologically is a Tonasa formation with a thickness of 3,000 m [1].

Pangkep karst area in general is an area of physical appearance in the form of Tonasa formations limestone. Limestone composed of 3 parts, namely, scaly limestone, crystalline limestones, and kalkarenit limestones. Pangkep karst area characterized by distinctive morphological forms a residual hills formed by dissolution, so there are some sinkhole and doline. The dissolution process may occur in the surface and subsurface karst. This enables the development of caves and underground tunnels as well as the presence of stalactites and stalagmites [2].

Generally, the karst region is characterized by the region in the form of basins, there are small hills, the rivers were visible on the surface is lost and disconnected to the soil, presence of rivers below the soil surface, the presence of red clay sediments result from the weathering of limestone, and the exposed surface appears rough, perforated and pointy [3]. As a result, there will be movement of fluid from one type of medium to another medium, because karst region medium is very heterogeneous. This incident effect fluid friction in the movement, so that the necessary information ability to pass the fluid. For more information karst region would be complete if the structure of the

subsurface materials were analyzed based on the permeability of the medium, because increasing population growth, the pressure on Pangkep karst ecosystems are increasing too and are likely to lead to environmental degradation. Without control efforts, karst damage certainly be counter-productive to the karst ecosystem values and functions that have been considered important to be developed and protected.

In karst areas Pangkep available natural resources that have the potential for tourism [4], agriculture [5], irrigation for raw water in Maros PDAM [6], the development of industrial areas (mining), recipient of urbanization. Therefore, the local government must provide support facilities especially basic human needs (resident) that is fresh water (clean water) so it needs to search the water source below ground level (ground water). The main problem is the lack of in-depth study of the potential hydrological in Pangkep-Maros karst region. Preliminary research conducted by showed the availability of groundwater in karst areas with good potential water sources ranged from 4.03 to 45.1 Ωm using by geoelectric resistivity Wenner configuration [7].

EXPERIMENTAL METHOD

This research was conducted in the Pangkep karst region, Pangkajene Kepulauan district, South Sulawesi, Indonesia. While the analysis in the Earth Physics Laboratory, Department of Physics, Faculty of Mathematics and Natural Science, University of State Makassar. This research was conducted in two stages, namely measurement of medium permeability and geoelectric measurements to analysis subsurface materials. Permeability measurements, carried out by taking 6 rock samples at different positions (L = 1.20; r and r_s = 1.20). Geoelectric measurements made after the analysis of permeability is completed. Field data acquisition using by the method of geoelectric resistivity Wenner configuration [8]. Data were collected in the survey area with the path length of 90 meters towards East-West trajectory, and produces 145 data with the largest current electrodes spacing of 9 meters, while the smallest current potential electrodes of 3 meters.

Permeability Analysis

Analysis of permeability has been conducted using falling head method, by comparing the height of water in each pipe. When water is put into the pipe, the water level was initially at a height H_1 and the water will flow through the sample so that the surface down to a height H_2. The time t required by the surface of the water to fall from H_1 to H_2 measured in this experiment [9]. The rate of fluid flow is expressed by the following equation:

$$Q = \pi r^2 \frac{dH}{dt} \tag{1}$$

Core sample shaped cylindrical with the radius r_s, so:

$$K = \frac{r^2 L}{r_s^2 t} \ln \frac{H_1}{H_2} \tag{2}$$

By knowing the water pipe radius r, the radius core sample r_s, sample length L, initial water levels H_1 and the end H_2 as well as time interval t required. Then the hydraulic conductivity K sample material (rock) is known and can be obtained permeability through the equation:

$$k = \frac{\kappa \eta}{\rho g} \tag{3}$$

where k is permeability (milidarcy = mD); ρ is density of fluid (g/cm^3).

Geoelectric Analysis

The results of the geoelectric measurements were then analyzed using MS. Excel. Interpretation of the data based on the pattern of pseudosection results inverse least-squares with Res2dinV software can be seen how the subsurface resistivity distribution of research areas [10].

RESULT AND DISCUSSION

Medium Permeability Karst Region Pangkep

Medium permeability measurements carried out by taking 6 rock samples at different positions in the karst region Pangkep. The results of the analysis of medium permeability with the falling head method are shown in Table 1. Table 1 shows the value of permeability for 6 samples including classification tight, that means the medium in the karst region Pangkep difficult to pass fluid. As a result, the penetration slowly, thus causing damage to the structure of the medium. In the long term, will have an impact on the medium's ability to withstand external forces (fluid) so that the process fluid transport into and surrounding medium is slow. Fluid will be retained on the particular conditions while applying pressure to the walls of medium to arise any cracks or gaps so that the fluid has the ability to of transportation. This is understandable, because the rock is limestone karst in general that has hardened. Generally, characteristic for the karst rocks are dark yellow brown [9].

TABLE 1. The results of the analysis of medium permeability.

Sample	Permeability (cm^2)	Permeability (D)
NT_1	0.87×10^{-8}	0.87
NT_2	0.97×10^{-8}	0.97
NT_3	0.53×10^{-9}	0.053
NT_4	0.89×10^{-8}	0.89
NT_5	0.63×10^{-8}	0.63
NT_6	0.87×10^{-8}	0.87

Subsurface Materials Karst Region Pangkep

The method of geoelectric resistivity Wenner configuration produce different resistivity values. The difference resistivity values can distinguish shapes layer of subsurface study area and the depth of each constituent layer. Analysis result is shown in Fig. 1.

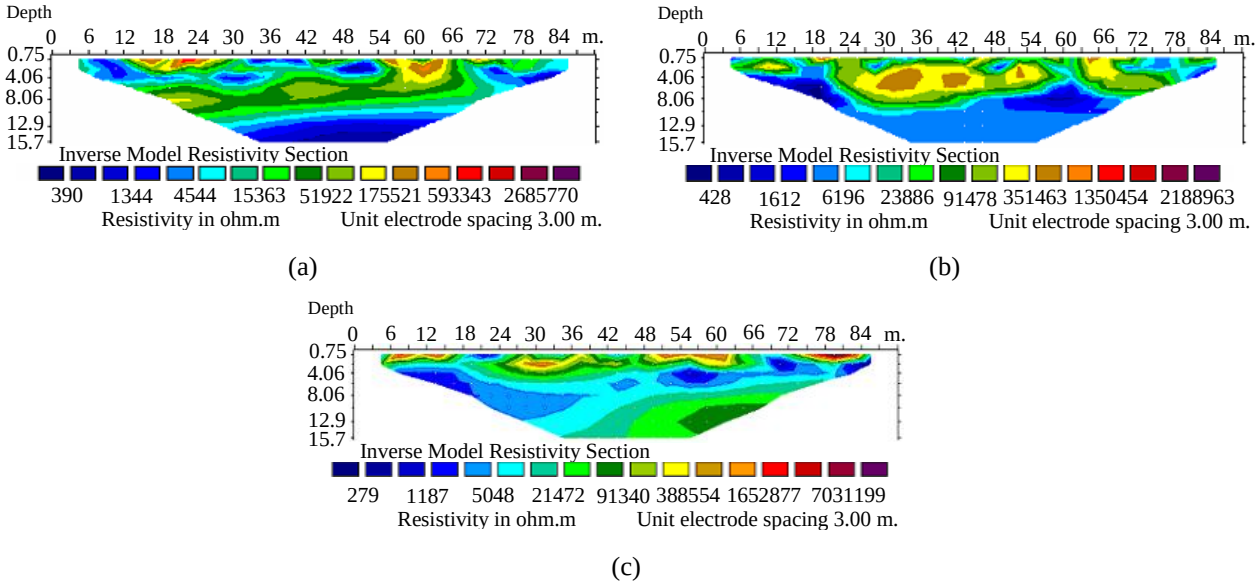

FIGURE 1. Resistivity distribution of karst region Pangkep (a) location 1, (b) location 2, and (c) location 3.

Figure 1 shows the resistivity distribution of Pangkep karst region. The area was detected about 90 m laterally to a depth of about 16 m and resistivity distribution from 390 Ωm-2,685,770 Ωm (Fig. 1a), 428 Ωm-2,188,963 Ωm (Fig. 1b), and 279 Ωm-7,031,199 Ωm (Fig. 1c). Based on resistivity distribution can be obtained at any location of materials (Table 2). Generally the water centralized in certain areas and confined by a dense medium. This can be seen especially on the path 3 where rock of quartz, basalt and limestone (starting depth of about 4 m to bottom) a major drag on the fluid so it can not penetrate. Contrast with the measurements on path 1 and path 2. Precisely on path 1 of the fluid at a depth of about 3 m in the area under (between 13 m-16 m) has a barrier such as quartz, basalt and limestone in the upper portion. For path 2, rock of quartz, basalt and limestone dominates this area.

TABLE 2. The values of resistivity subsurface materials karst region Pangkep.

Color	Resistivity (Ωm)	Type of Materials
Violet-blue	279-1,612	sand, clay, slate, surface water, and groundwater
Medium-blue	1,612-6,196	quartz, granite, basalt, and limestone
Green	15,360-388,554	salt, rocks and andesite

Geoelectric measurements using the Wenner method gives an overview of the distribution of rocks resistivity and subsurface structures. The value difference of current strong flowing through the subsurface is very dependent on the physical properties of the material in its path. Besides, the role of liquid contained by the rock also affects whether there is an electrolyte or non-electrolyte solution. Determination of the material contained on the rocks need to know the local geological conditions where measurement locations are (path 1, 2, and 3).

CONCLUSIONS

Based on the results and discussion, the conclusions of this study are the value of medium permeability karst region Pangkep to 6 measurement points was 0.87 D, 0.97 D, 0.053 D, 0.89 D, 0.63 D and 0.87 D. Type of material contained in subsurface karst region Pangkep to depths of up to 15.70 m with the values of conductivity 279-1612 Ωm are sand, clay, slate, surface water, and groundwater. The values of conductivity 1612-6196 Ωm for the material type of rock quartz, granite, basalt, and limestone. The values of conductivity 15360-388554 Ωm for the material type of salt, rocks and andesite.

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